

Fig. 1A (prior art)

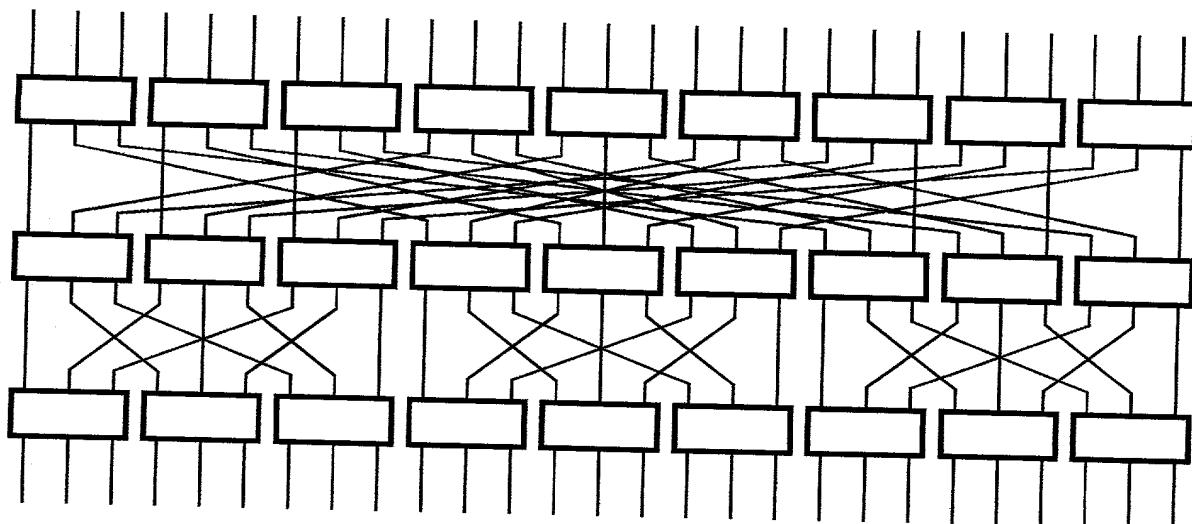


Fig. 1B (prior art)

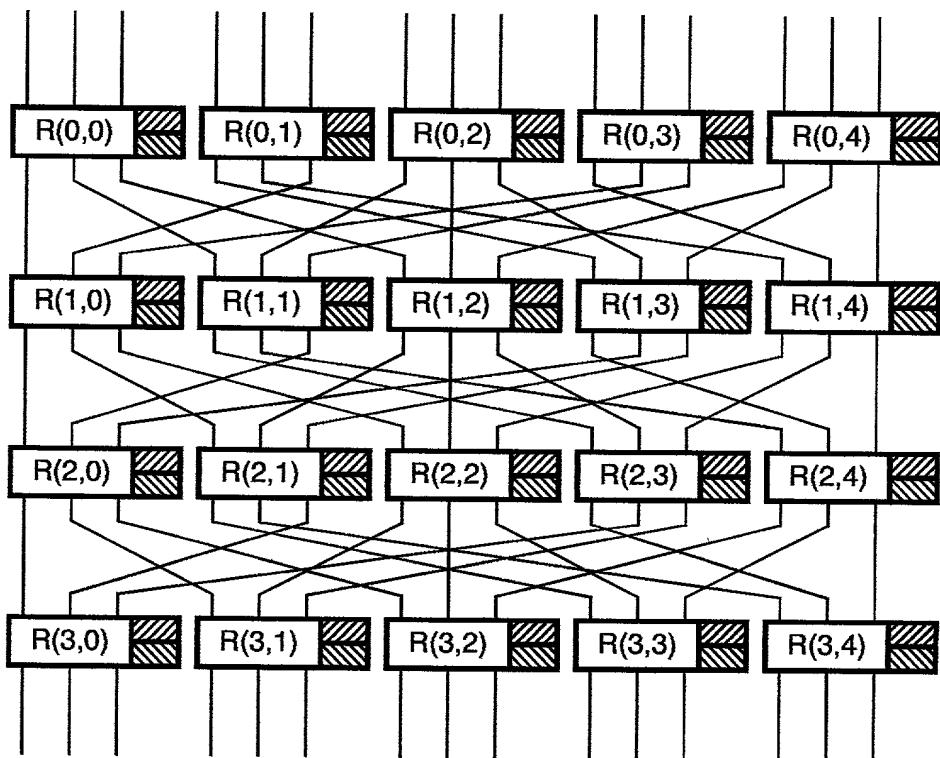


Fig. 2

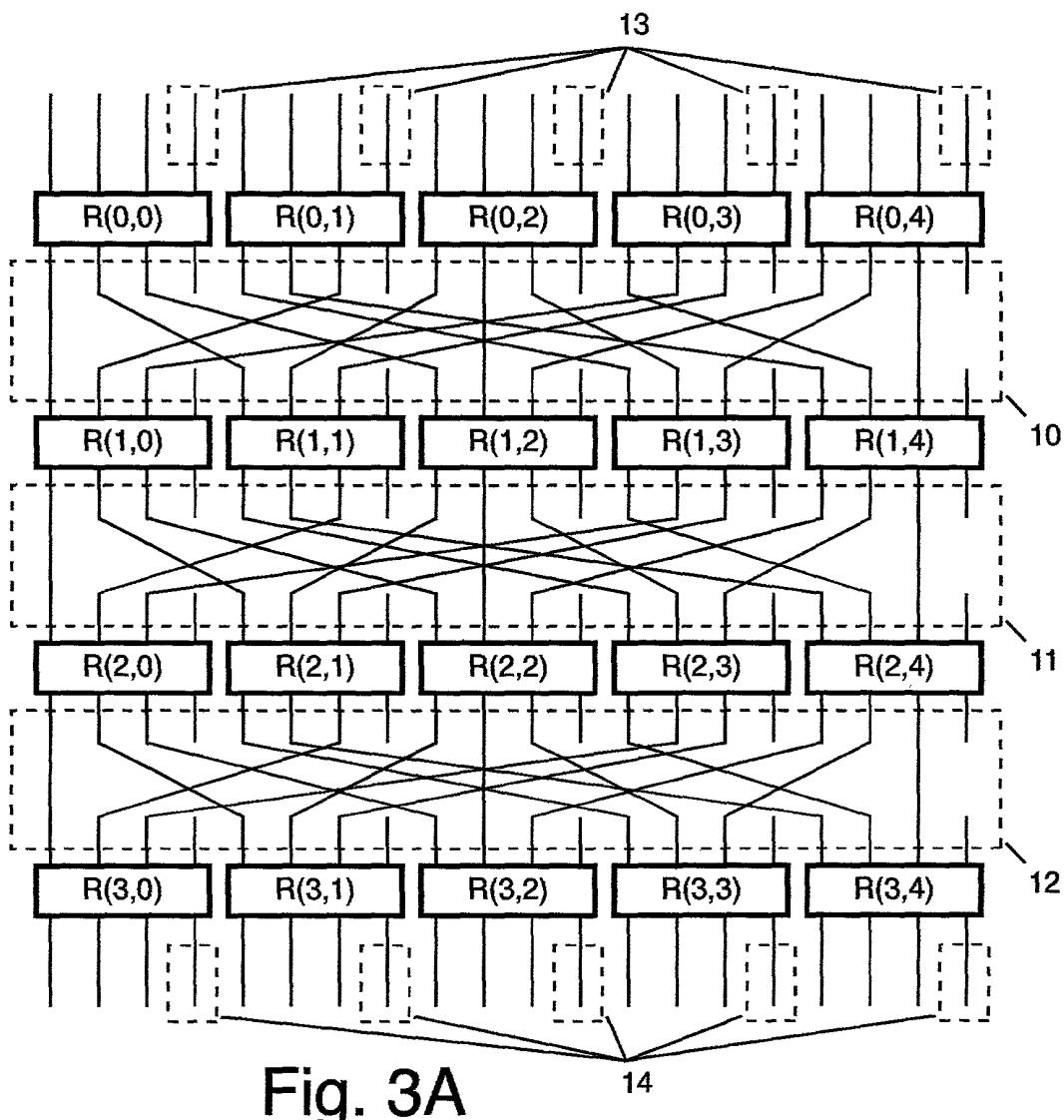


Fig. 3A

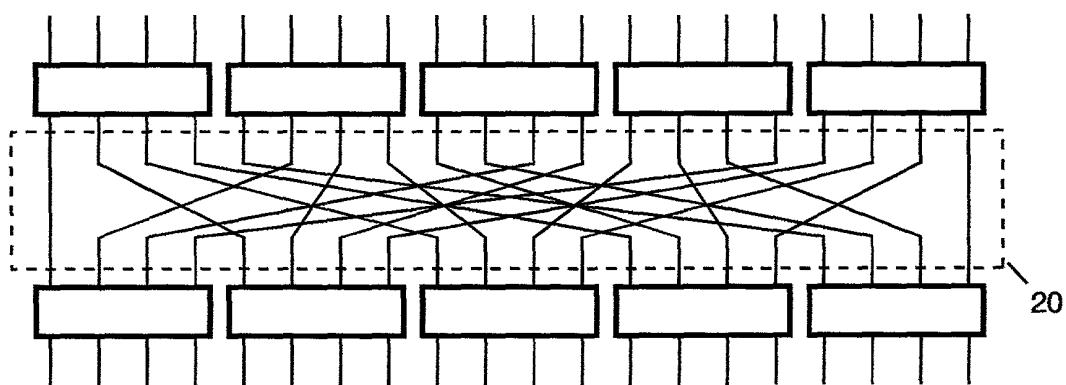


Fig. 3B

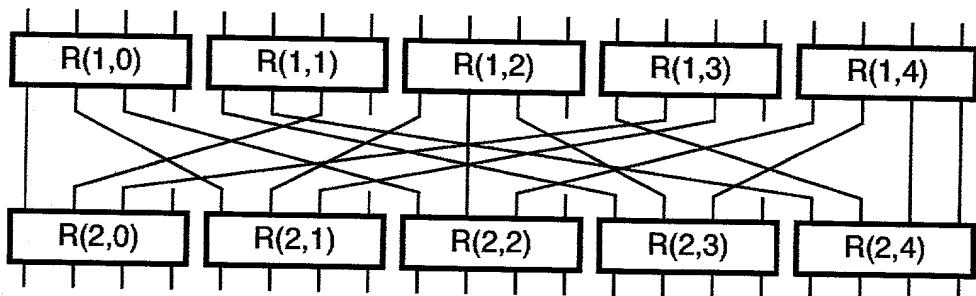


Fig. 4A

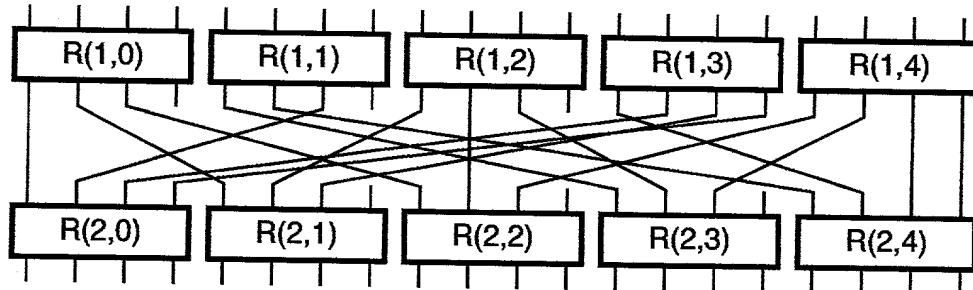


Fig. 4B

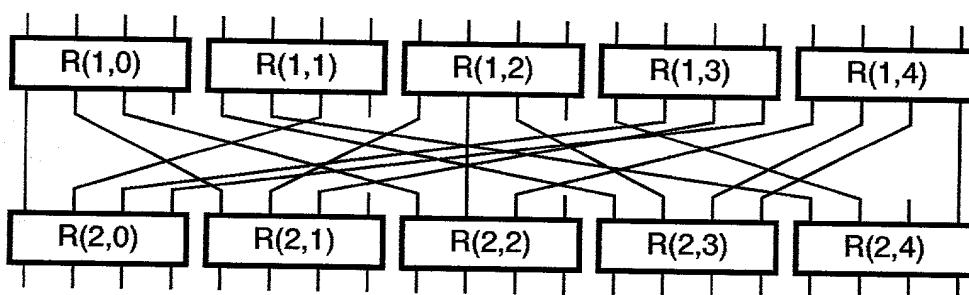


Fig. 4C

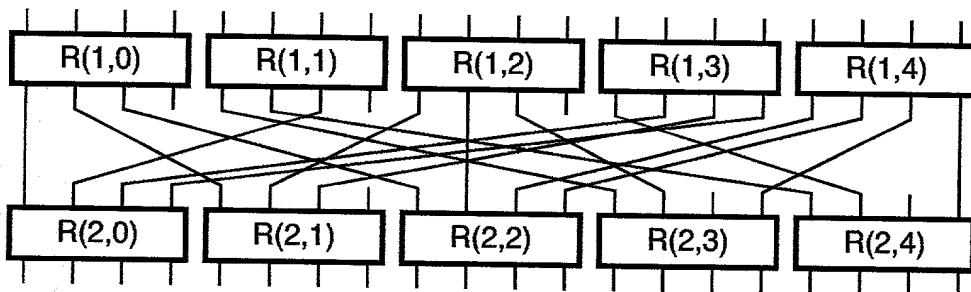


Fig. 4D

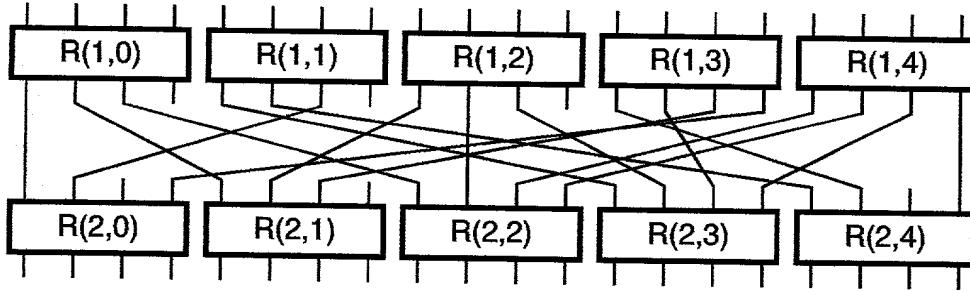


Fig. 4E

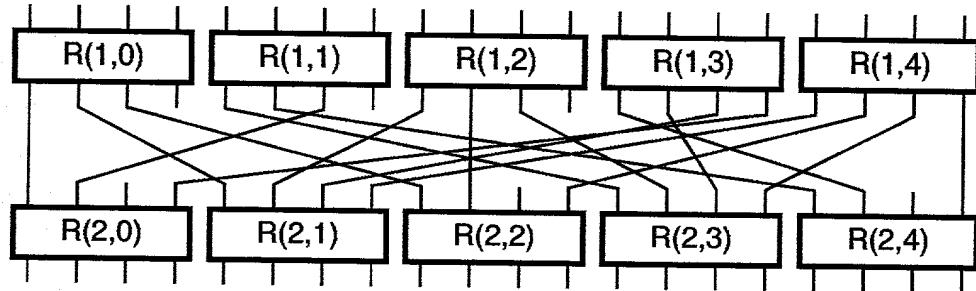


Fig. 4F

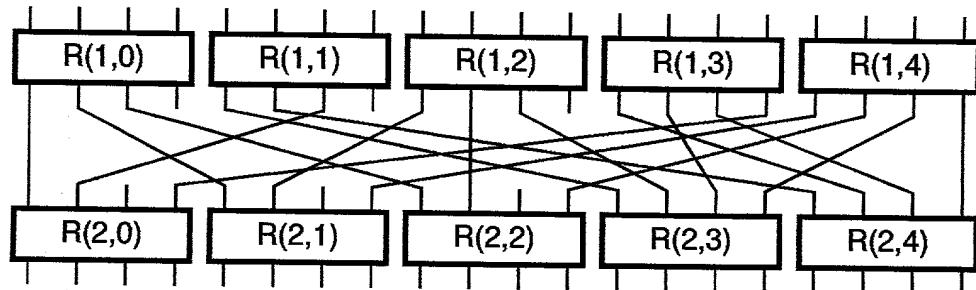


Fig. 4G

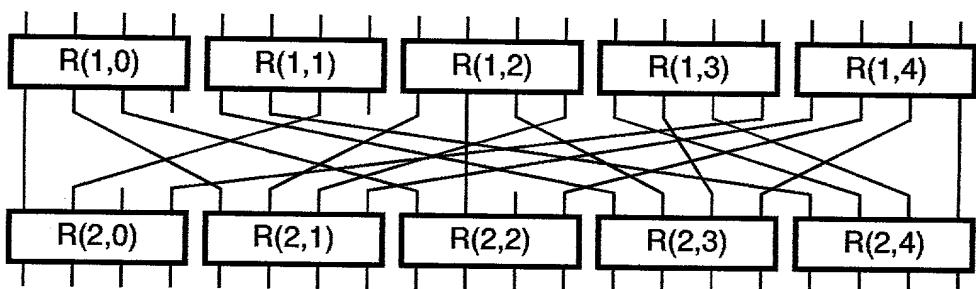


Fig. 4H

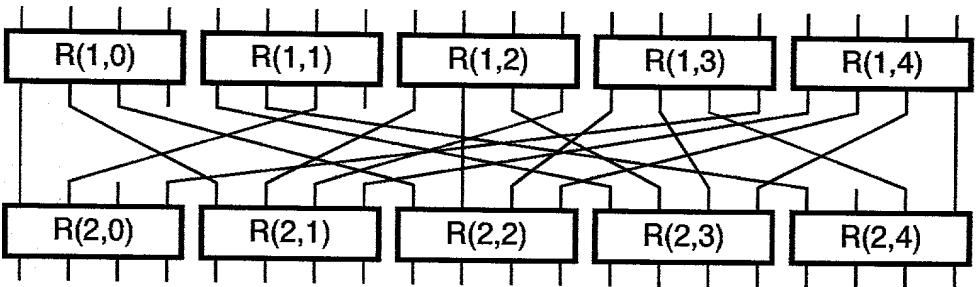


Fig. 4I

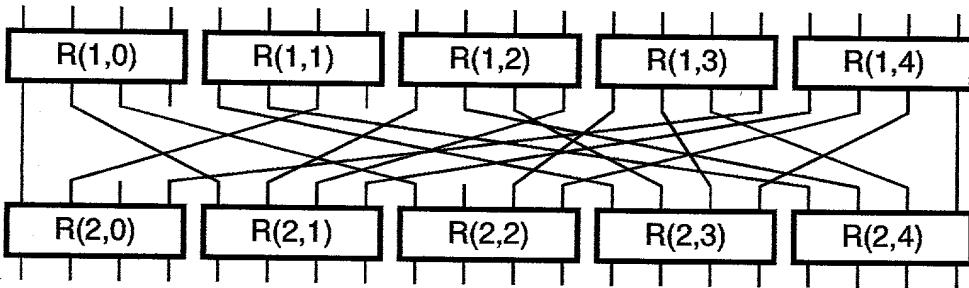


Fig. 4J

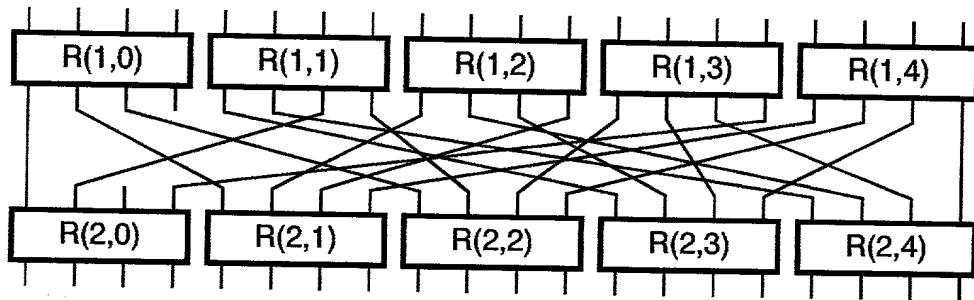


Fig. 4K

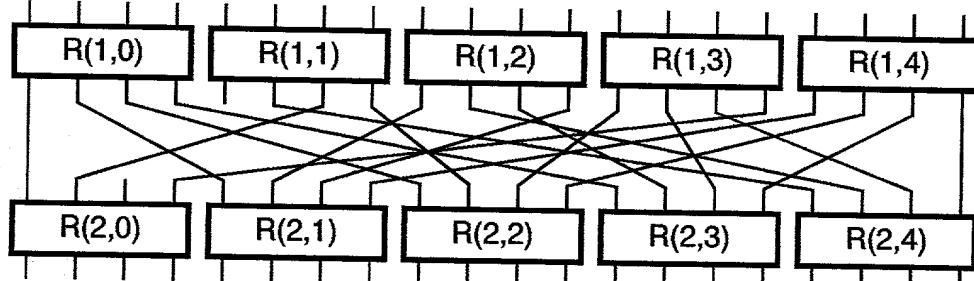


Fig. 4L

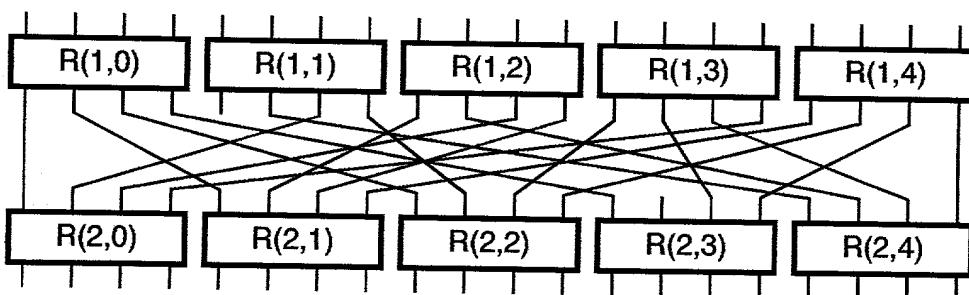


Fig. 4M

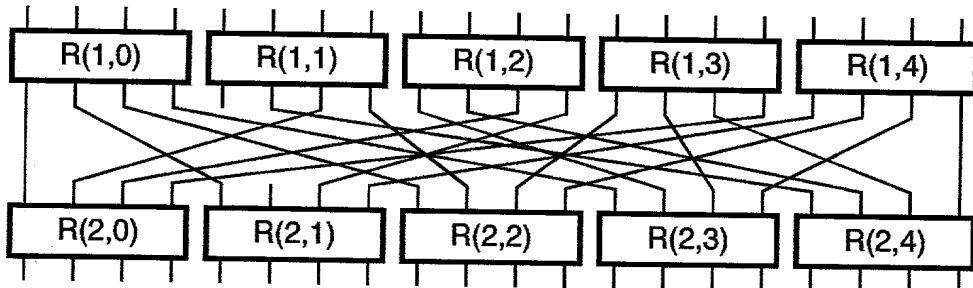


Fig. 4N

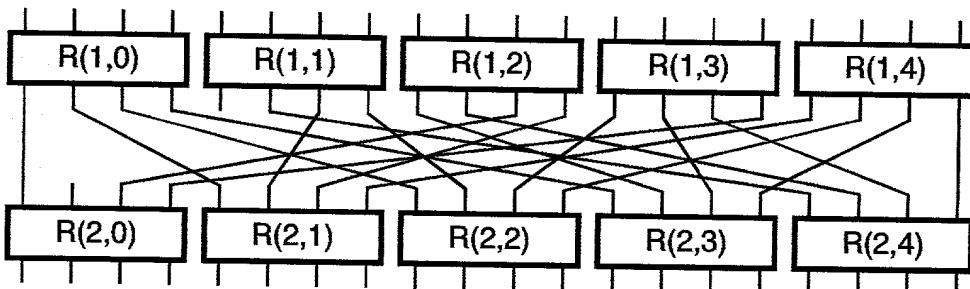


Fig. 4O

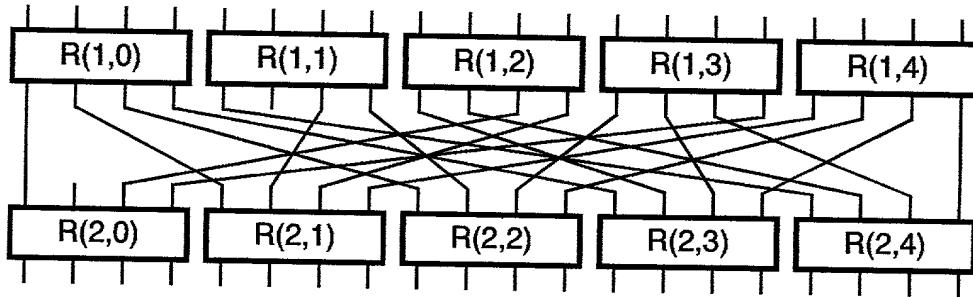


Fig. 4P

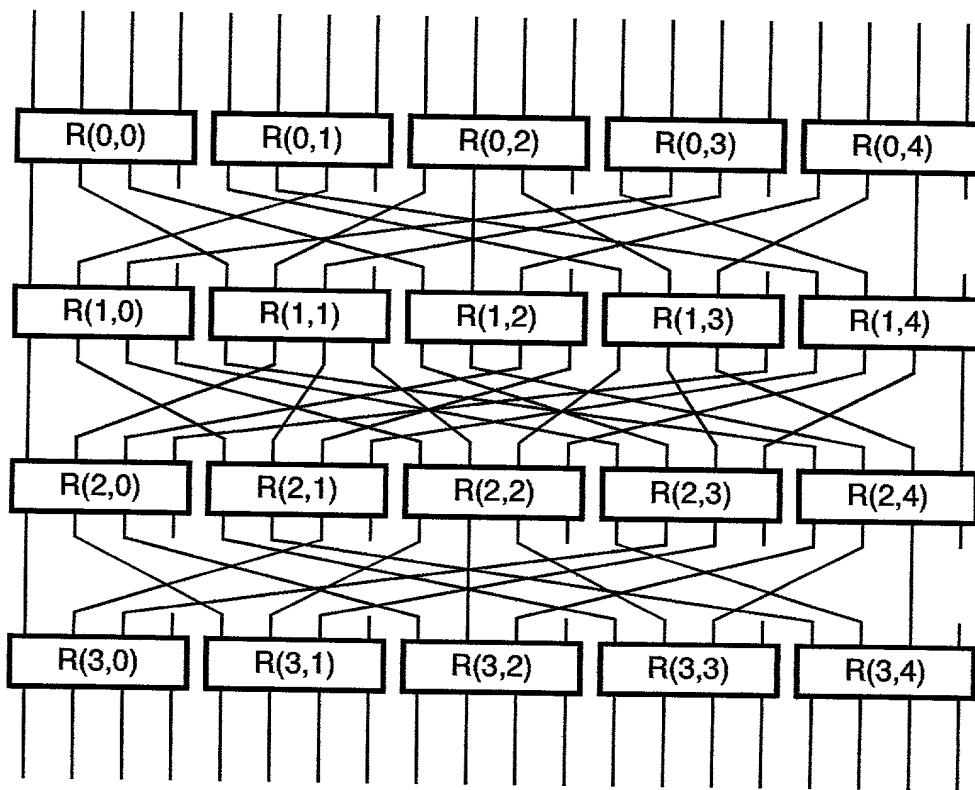


Fig. 4Q

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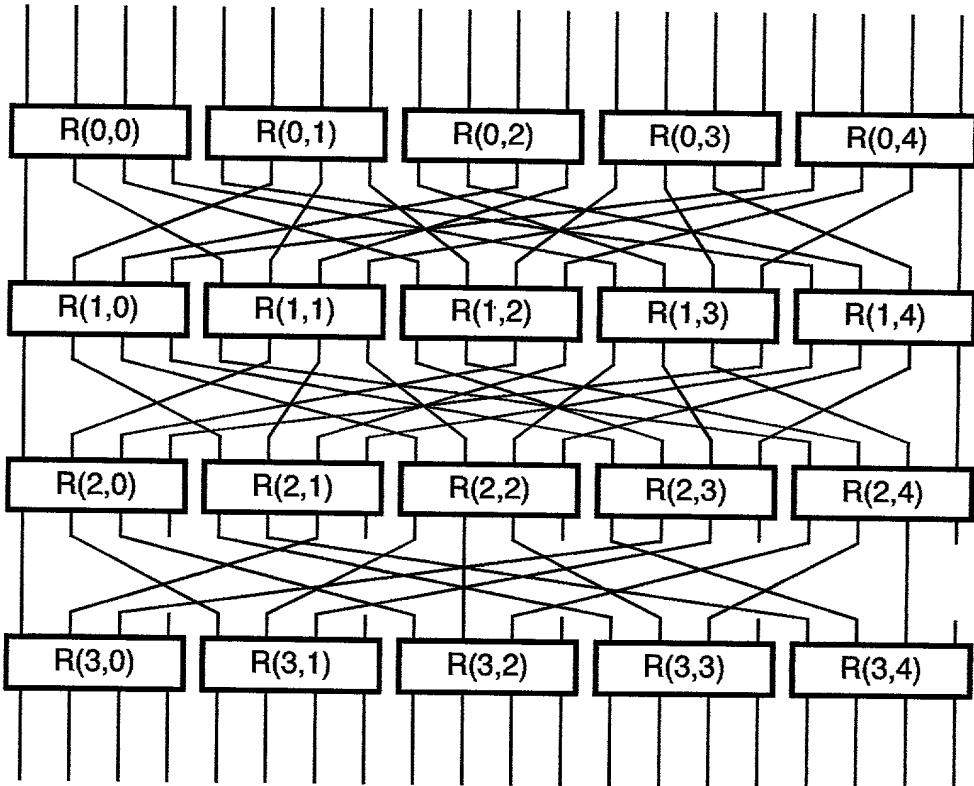


Fig. 5A

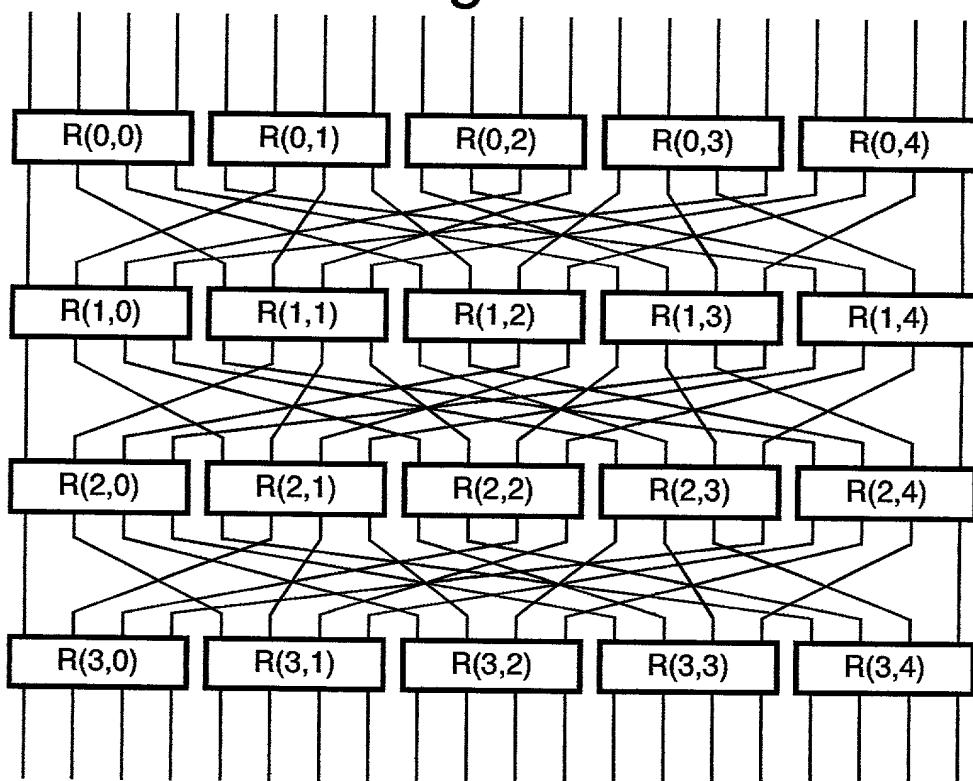


Fig. 5B

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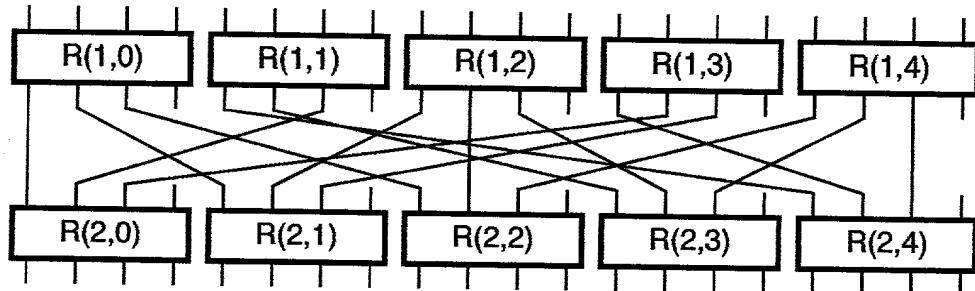


Fig. 6A

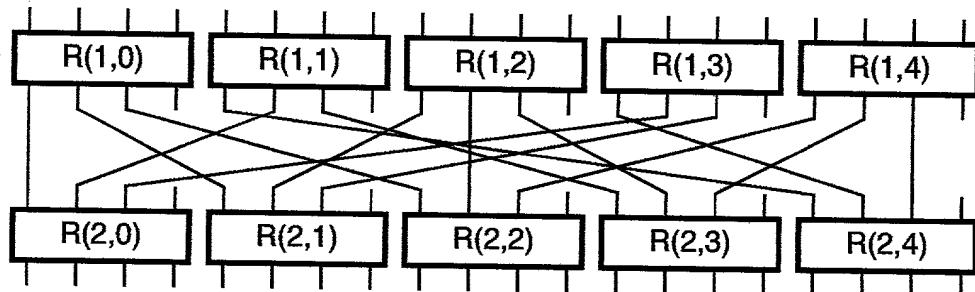


Fig. 6B

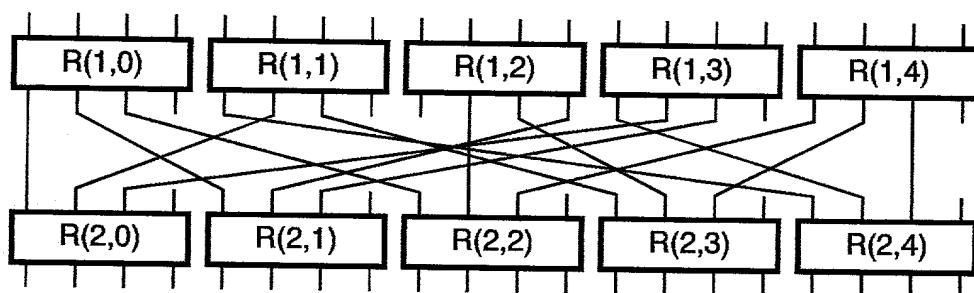


Fig. 6C

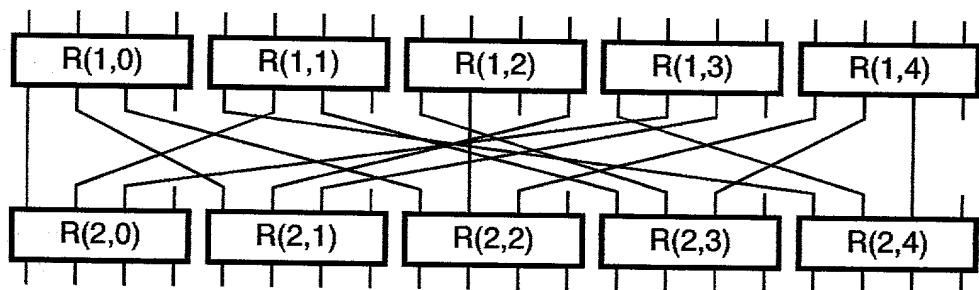


Fig. 6D

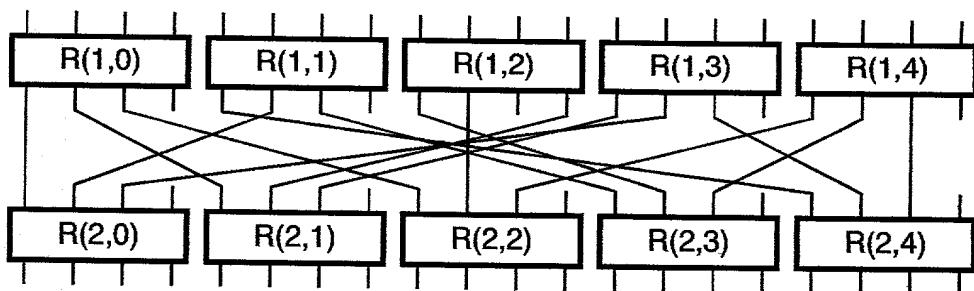


Fig. 6E

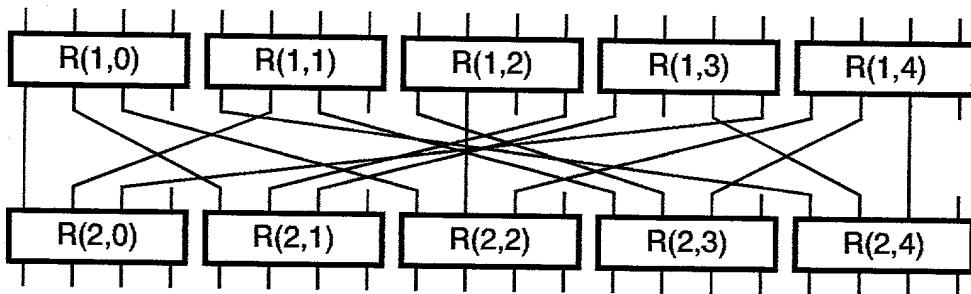


Fig. 6F

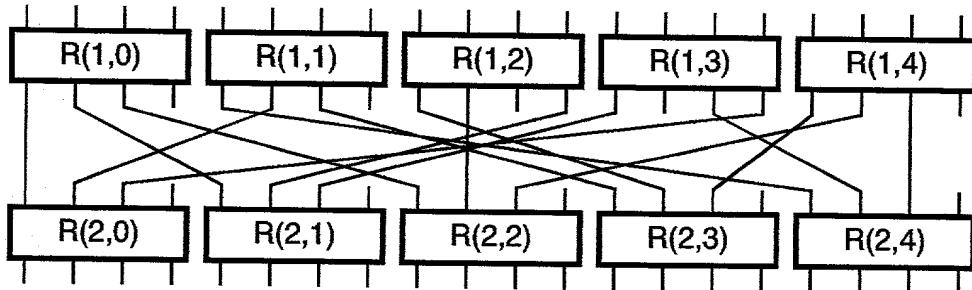


Fig. 6G

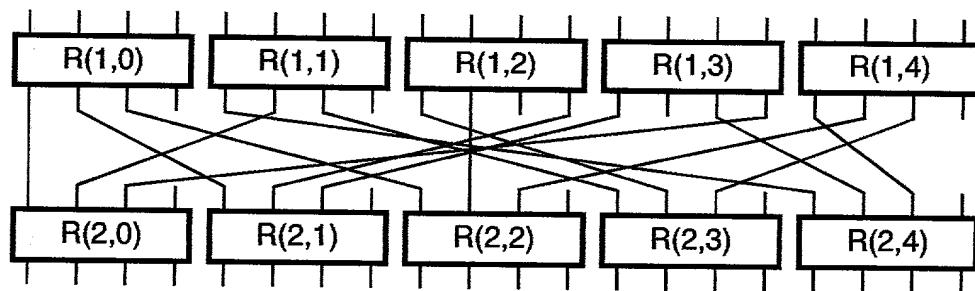


Fig. 6H

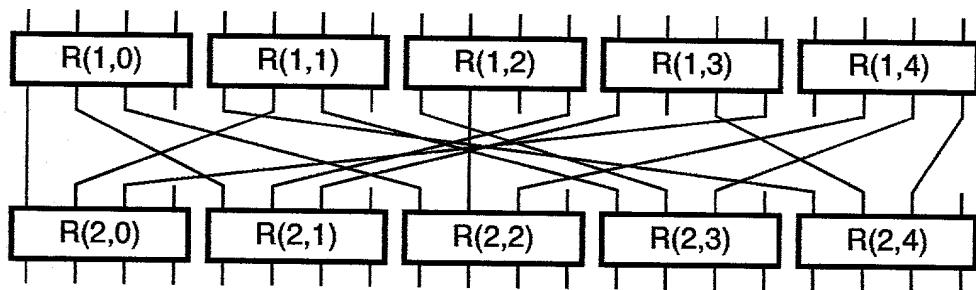


Fig. 6I

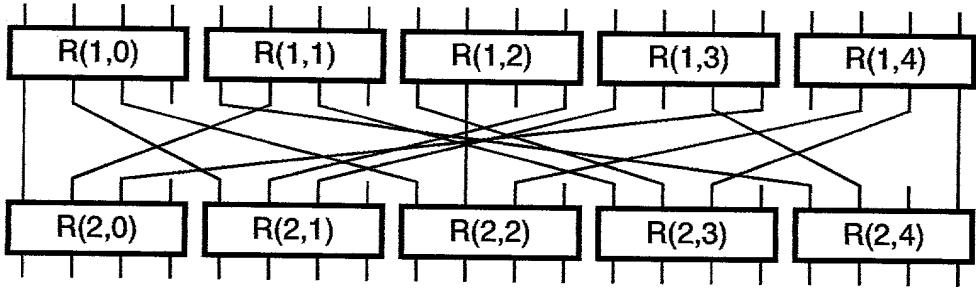


Fig. 6J

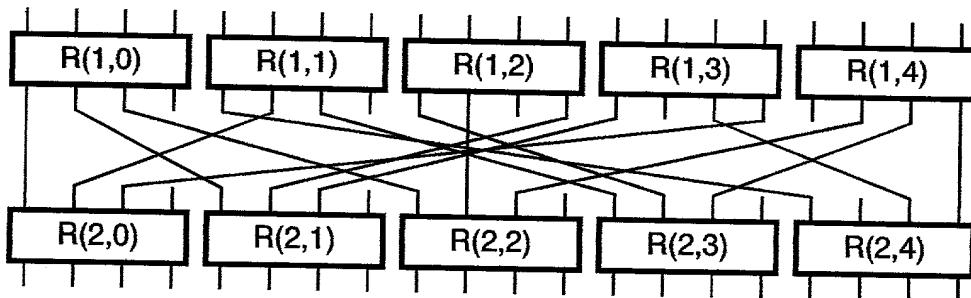


Fig. 6K

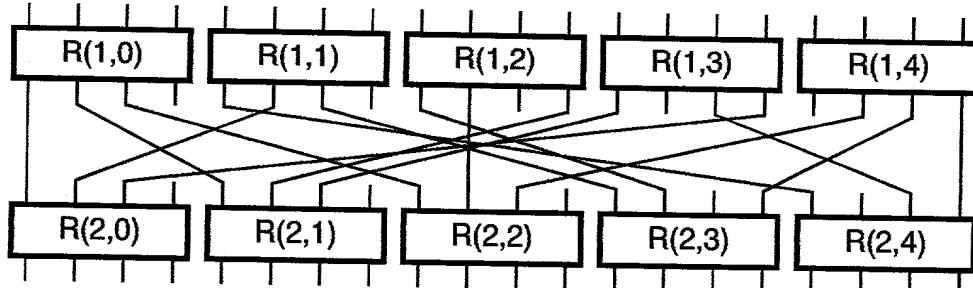


Fig. 6L

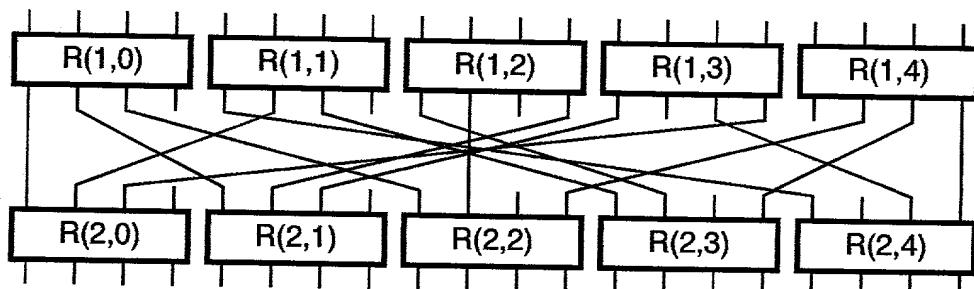


Fig. 6M

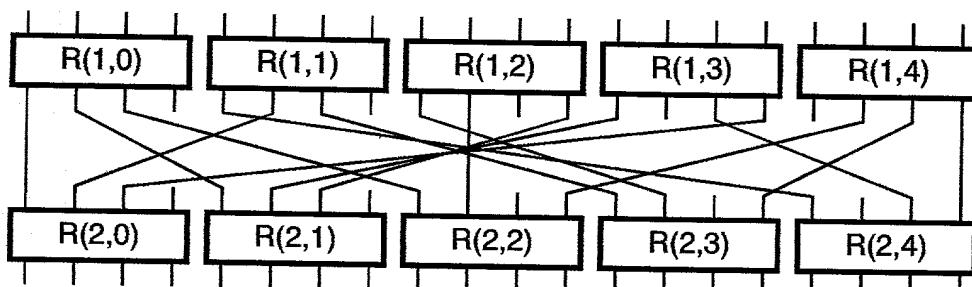


Fig. 6N

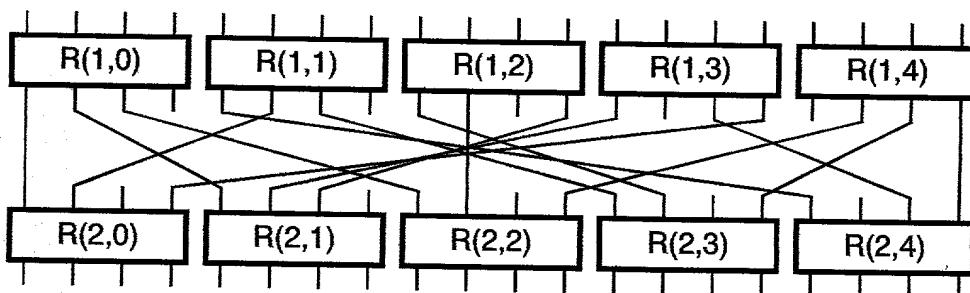


Fig. 6O

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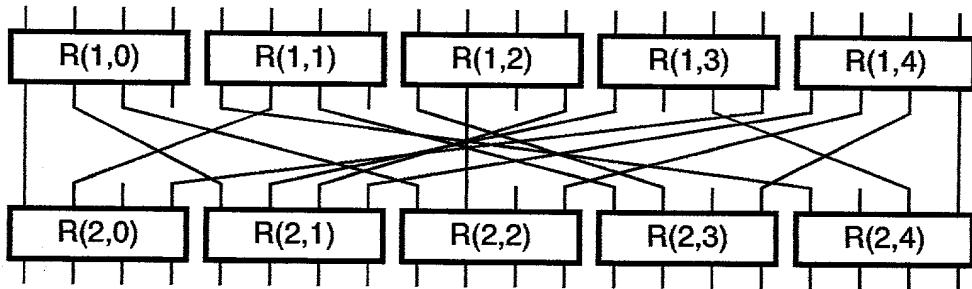


Fig. 6P

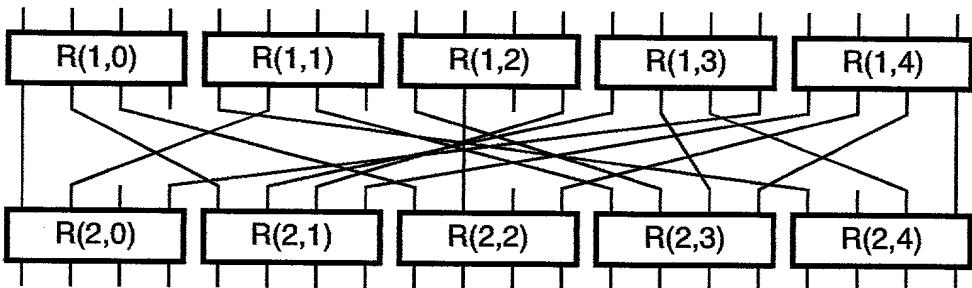


Fig. 6Q

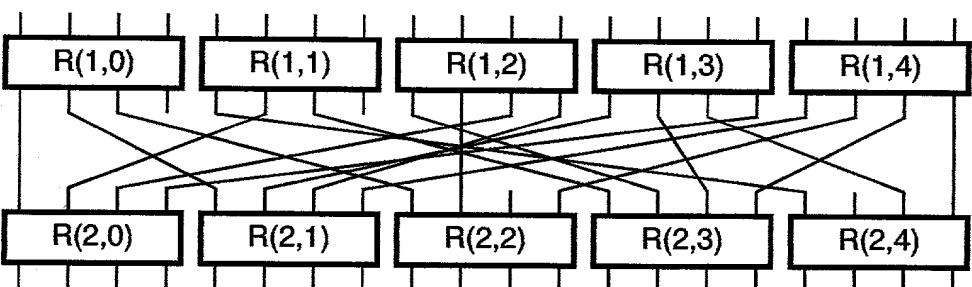


Fig. 6R

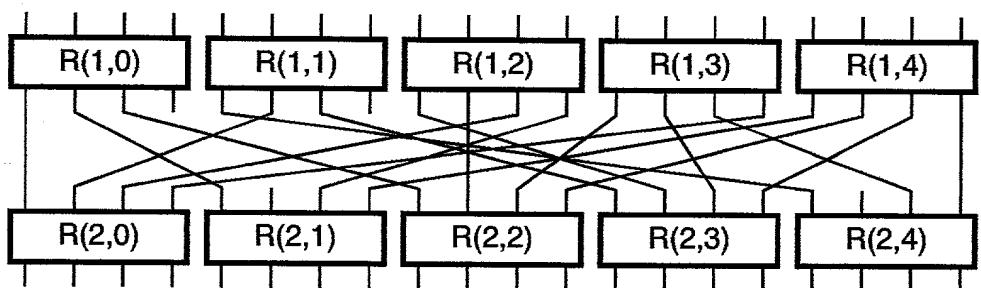


Fig. 6S

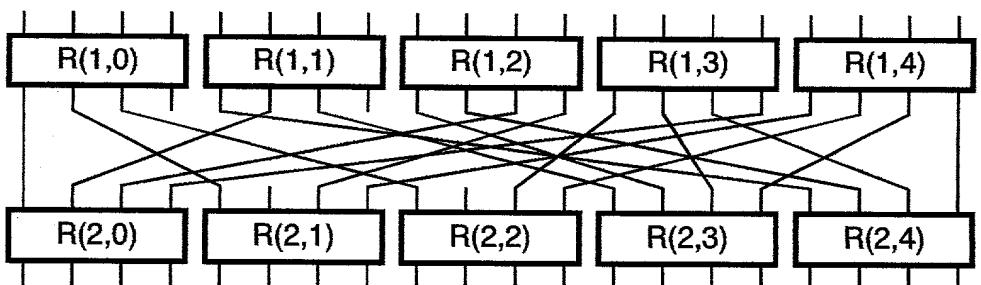


Fig. 6T

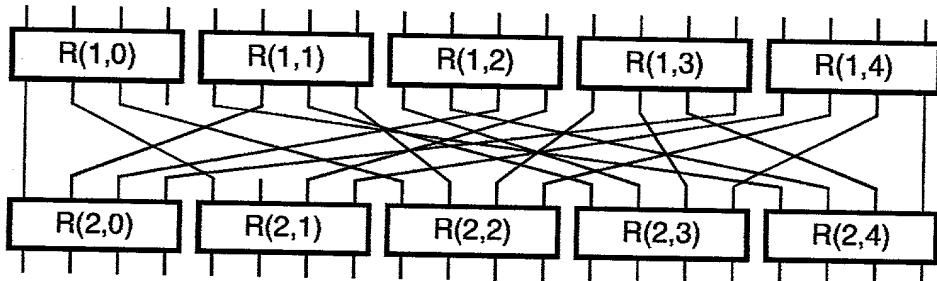


Fig. 6U

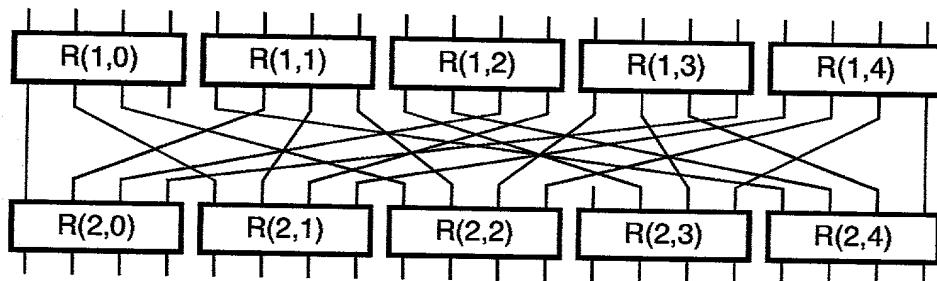


Fig. 6V

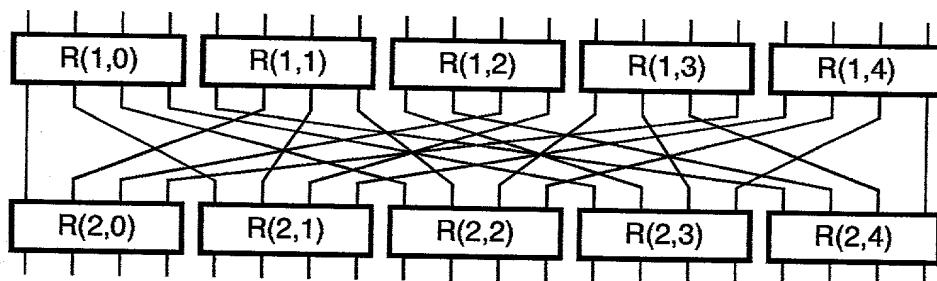


Fig. 6W

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```

//
//Procedure Upgrade
//    Performs a fanout upgrade of a network.
//    "want to relabel" may be "true" or "false" each time the statement is reached
//
Procedure Upgrade
do {
    select any router requiring addition of ports
    add_ports(router);
} while (there are routers requiring new ports);
do {
start:
    if(want to relabel) {
        if(any router, current_router, can be relabeled) {
            relabel_ports(current_router);
            goto start;
        }
    }
    select any port not connected to corresponding_port(port);
    target_port=corresponding_port(port);
    if(target_port is already connected) {
        disconnected_port=port currently connected to target_port;
        Disconnect(target_port,disconnected_port);
    }
    Connect(port,target_port);
} while(there are misconnected ports);
connect_external_ports();
activate_external_ports();

```

Fig. 7A

```

// Procedure Upgrade
// Performs a fanout upgrade of an RCCBG network with an upgraded fanout of fanout,
// num_routers_per_row per row, and num_rows total rows. Also,
// RELABEL_AVAILABLE flag if swapping of ports in a single router can be performed without
// breaking connections.
//
Procedure Upgrade
do {
    select any router requiring addition of ports
    add_ports(router);
} while (there are routers requiring new ports);

for(rindex=0;rindex<num_rows-1;rindex++) {
    current_row=row_select(rindex);
    if(RELABEL_AVAILABLE) {
        relabel_ports(current_row);
    }
    disconnected_port=None; // Holds the port previously disconnected by the last rewire step
    while((port=select_port(disconnected_port,current_row))!=None) {
        target_port=corresponding_port(port);
        if(target_port is already connected) {
            disconnected_port=port currently connected to target_port;
            Disconnect(target_port,disconnected_port);
        }
        Connect(port,target_port);
    }
    connect_external_ports();
    activate_external_ports();
}

```

Fig. 7B

```

//  

//Simplification functions.  

//  

Function correct_port(port1,port2)  

{  

    if(port1 can be properly connect to port2) return(TRUE);  

    else return(FALSE);  

}  

Function corresponding_port(port)  

{  

    if(port is a bottom port) {  

        return top port of router in next row that should be properly connected to port port;  

    } else {  

        return bottom port of router in the previous row that should be properly connected to port port;  

    }  

}  

Function Disconnect(port1,port2)  

{  

    Divert traffic away from port1 ;  

    Divert traffic away from port2 ;  

    Disconnect connection between port1 and port2 ;  

}  

Function Connect(port1,port2)  

{  

    Connect port1 and port2 ;  

    Allow traffic to flow through port1 ;  

    Allow traffic to flow through port2 ;  

}

```

Fig. 7C

```
Function row_select(row_index) {
    if(num_rows is even) {
        start_row=num_rows/2-1;
    } else {
        start_row=(num_rows-1)/2;
    }
    if(row_index is even) {
        return(start_row+row_index/2);
    } else {
        return(start_row-(row_index+1)/2);
    }
}
```

Fig. 8A

```
Function row_select(row_index) {
    return(row_index);
}
```

Fig. 8B

```

Function select_port(dport,current_row) // optimal dport is not used
{
    port_pool={port: bottom ports of routers in row, current_row and top port of routers in row,
               current_row+1 not connected to corresponding_port(port)};
    // For simplicity order right to left
    // First criterion
    for port in port_pool {
        if(disconnected(port) && disconnected(corresponding_port(port)))return(port);
    }
    // Second criterion: This basically says we prefer to target connections that break
    // connections only on fully populated routers
    for port in port_pool {
        if(disconnected(port) &&
           num_disconnections(router_of_port_connected_to(corresponding_port(port))=0))) {
            return(port);
        }
    }
    // Third criterion: Any port that is not connected
    for port in port_pool {
        if(disconnected(port)) return(port);
    }
    // Catch all for any ports left over: Not likely to be needed
    for port in port_pool {
        return(port);
    }
    return(None);
}

```

Fig. 9A

```

Function select_port(dport,row) //fill the hole
{
    if(dport !=None) return(dport);
    else {
        for all bottom ports, port, of routers in row current_row scanning from right to left {
            if(port is not connected to corresponding_port(port)) return(port);
        }
        return None; // No more ports to rewire
    }
}

```

Fig. 9B

```

Function select_port(dport,current_row) // round robin
{
    // This requires a FIFO of ports
    if(port_fifo empty) {
        port_fifo={port: bottom ports of routers in row, current_row and top port of routers in row,
                  current_row+1 which are disconnected};
    }
    if(port_pool empty) {
        port_pool={port: bottom ports of routers in row, current_row and top port of routers in row,
                  current_row+1 not connected to corresponding_port(port)};
        for port in port_pool {
            return(port);
        }
    }
    // Catch all for any ports left over: Not likely to be needed
    port=any port not connected to proper port
    if(port exists) {
        return(port);
    }else {
        return(None);
    }
}
port=top of port_fifo ;
remove top of port_fifo ;
return(port);
}

```

Fig. 9C

```

Function relabel_ports(current_row)
{
    for(i=0;i<routers_per_row;i++) {
        for(bport1=0;bport1<fanout;bport1++) {
            for(bport2=0;bport2<fanout;bport2++) {
                //Test to see if the candidate port is connected to a router which one of the
                //other ports on the same router should be connected to. It doesn't matter
                //at this point if it is the correct top port. That will be corrected in next loop.
                if(bottom port bport1 of R(current_row,i) is connected to any top port of
                    router_of corresponding_port(bottom port bport2 of R(current_row, i)) {
                    if(bport1!=bport2) {
                        exchange_ports(bport1 of R(current_row, i),bport2 of R(current_row, i));
                    }
                }
            }
        }
    }

    for(tport1=0;tport1<fanout;tport1++) {
        for(tport2=0;tport2<fanout;tport2++) {
            //Test to see if the candidate port is connected to a port which one of the
            //other ports on the same router should be connected to.
            if(top port tport1 of R(current_row+1, i) is connected to
                corresponding_port(top port tport2 of R(current_row+1, i)) {
                if(tport1!=tport2) {
                    exchange_ports(tport1 of R(current_row+1, i),tport2 of R(current_row+1, i));
                }
            }
        }
    }
}

//Auxiliary Procedures
//

Function router_of(port)
{
    return(the router which port belongs to);
}

//Here logical relabelling is assumed possible
//Other exchange schemes can be substituted
//

Function exchange_ports(port1, port2)
{
    permanently divert traffic originally intended for port1 to port2 ;
    permanently divert traffic originally intended for port2 to port1 ;
}

```

Fig. 10

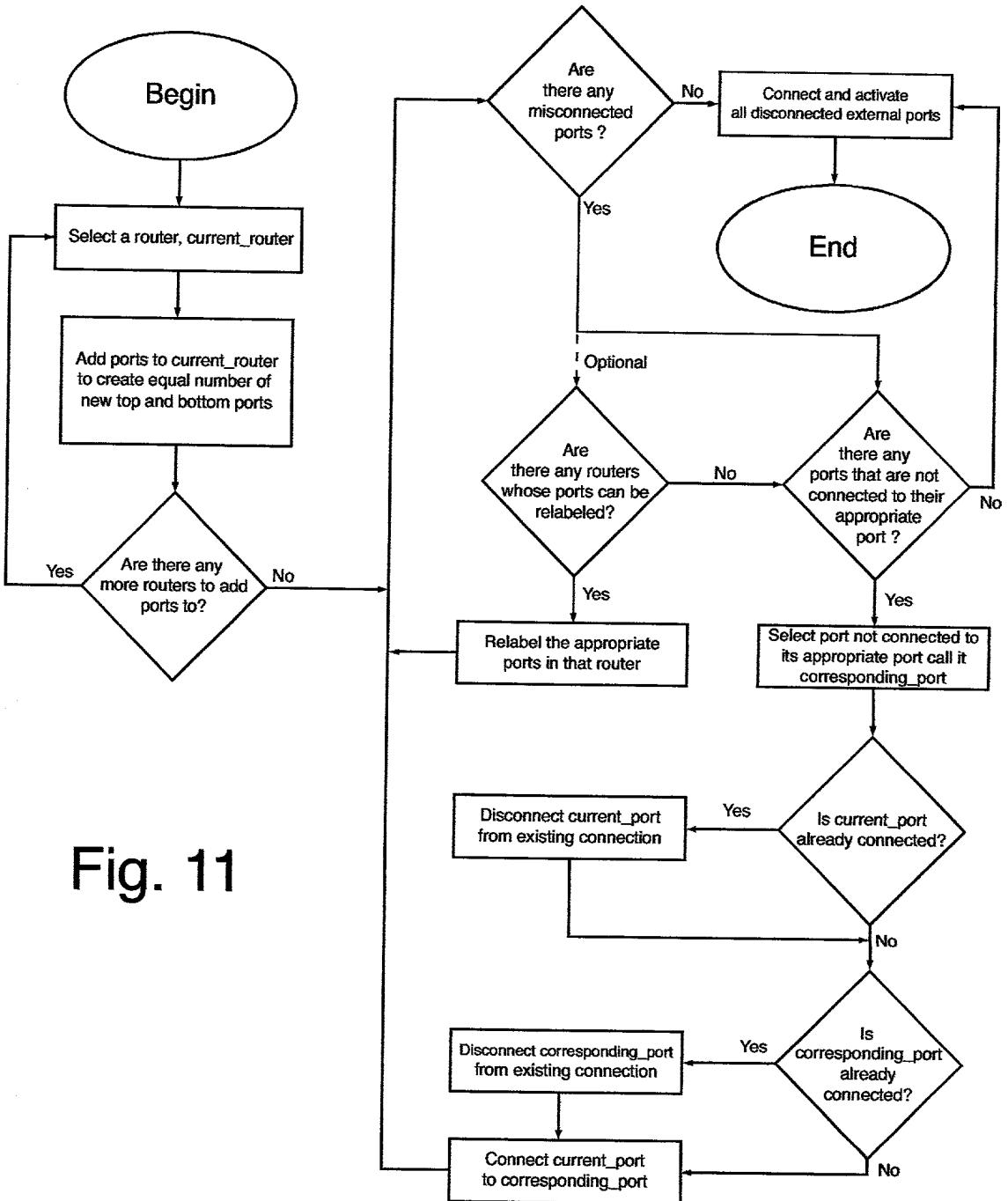


Fig. 11

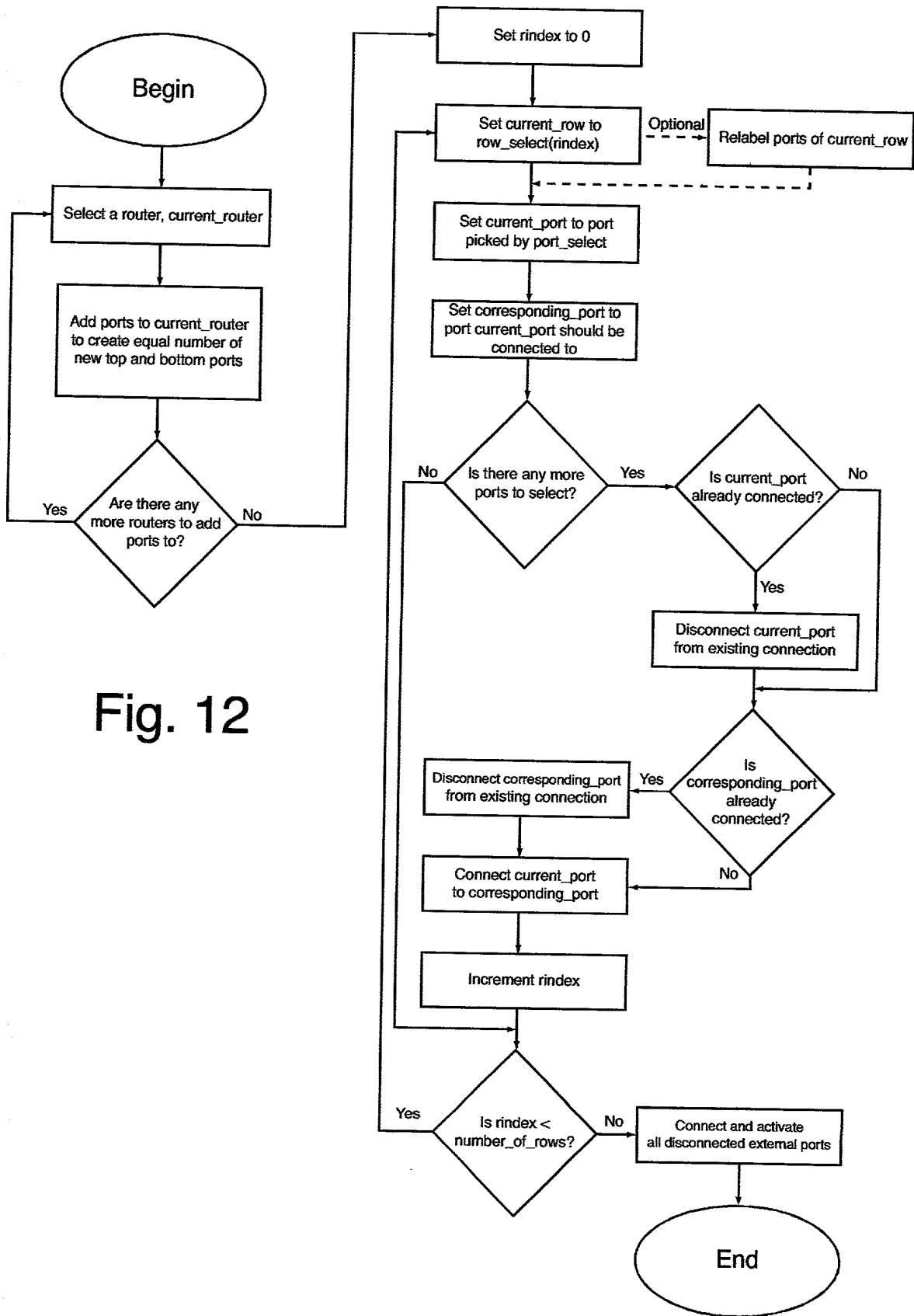


Fig. 12

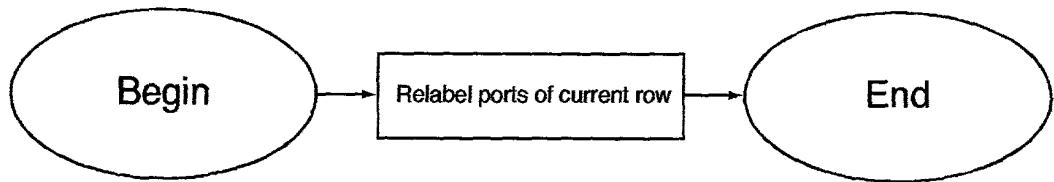


Fig. 13A

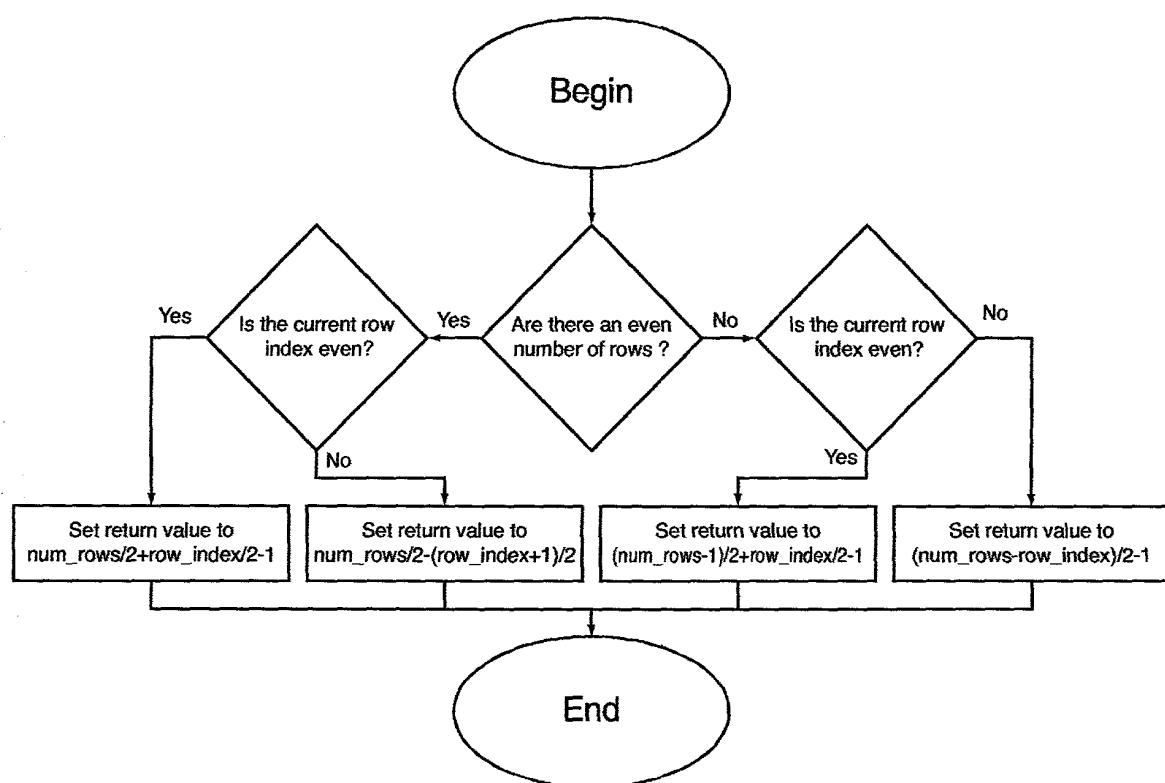
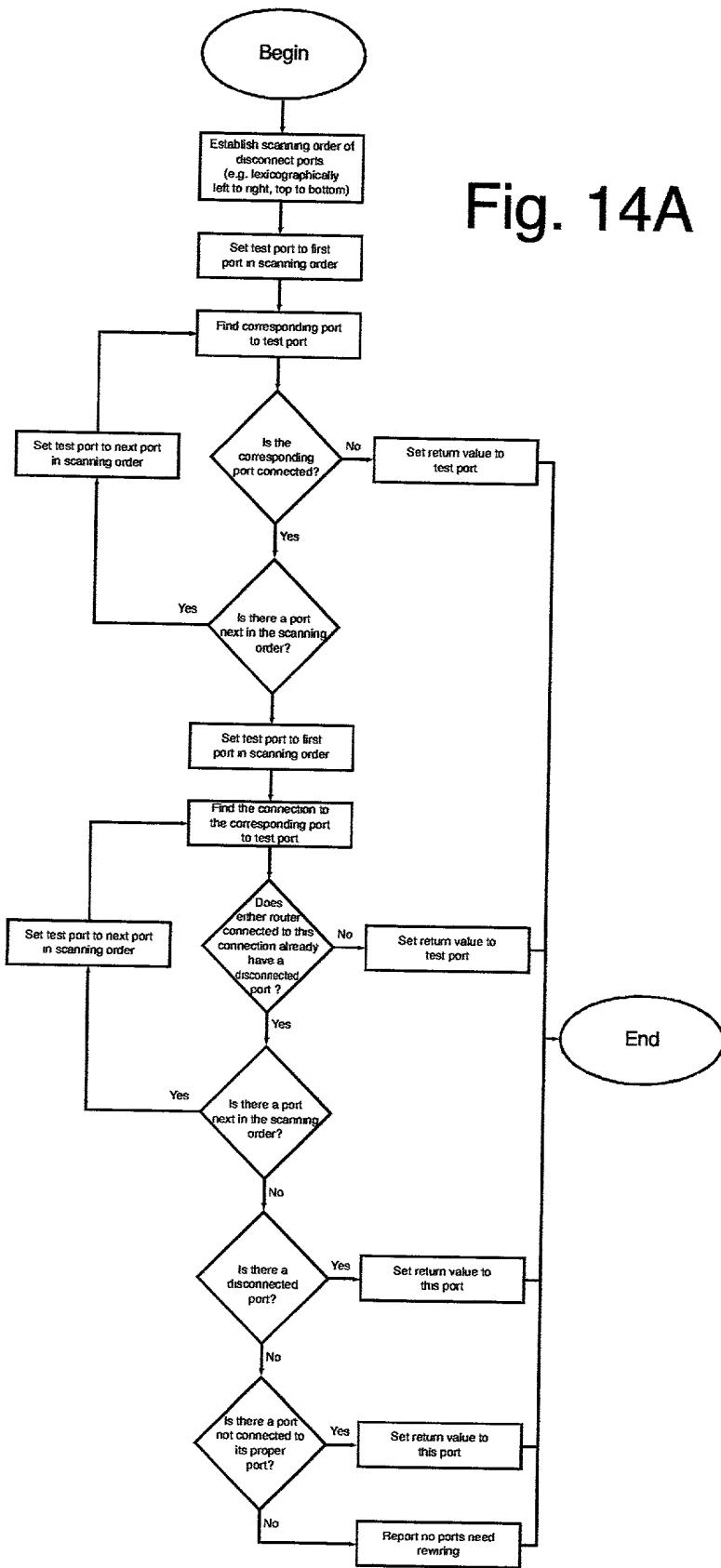


Fig. 13B

Fig. 14A



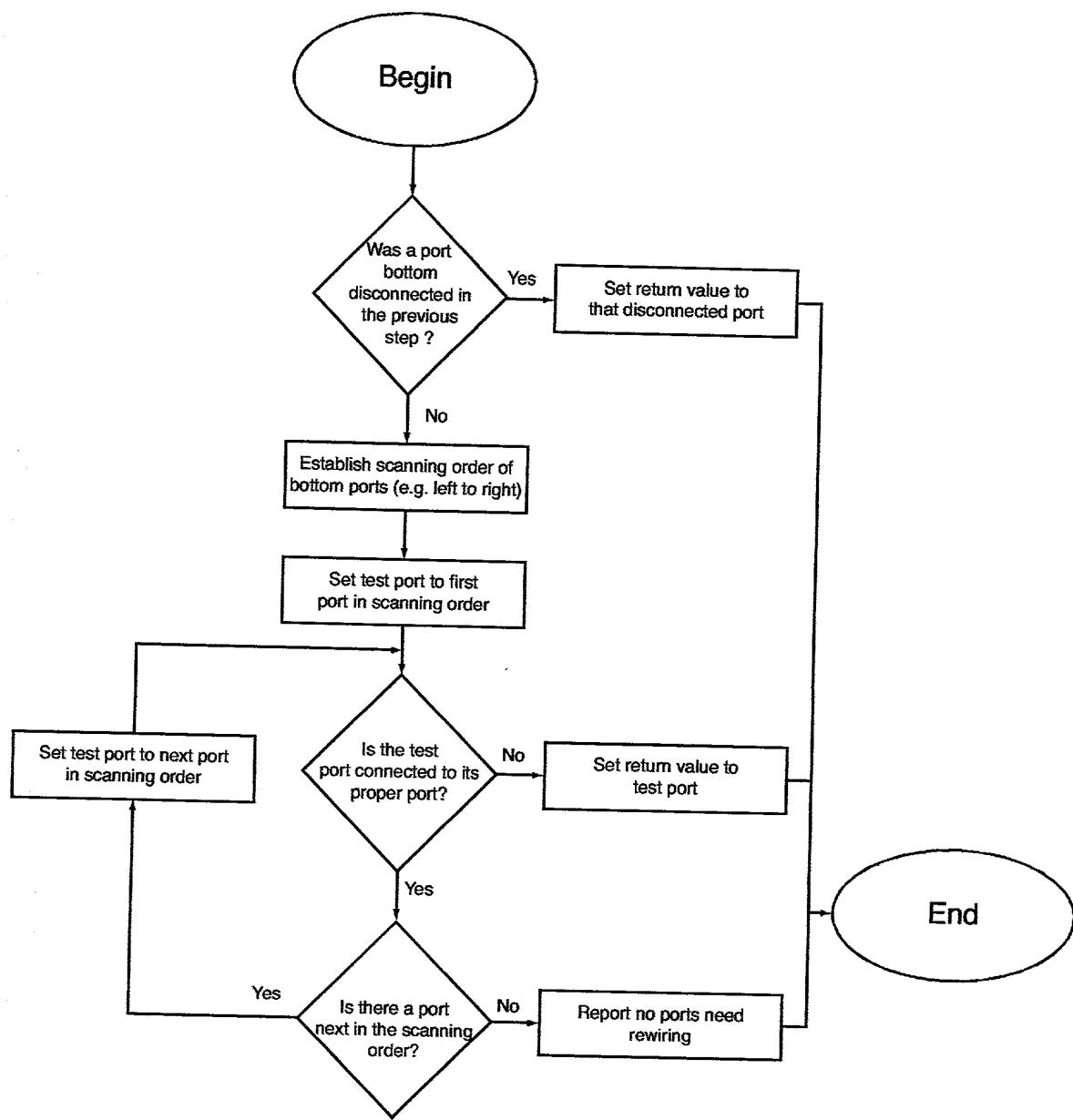


Fig. 14B

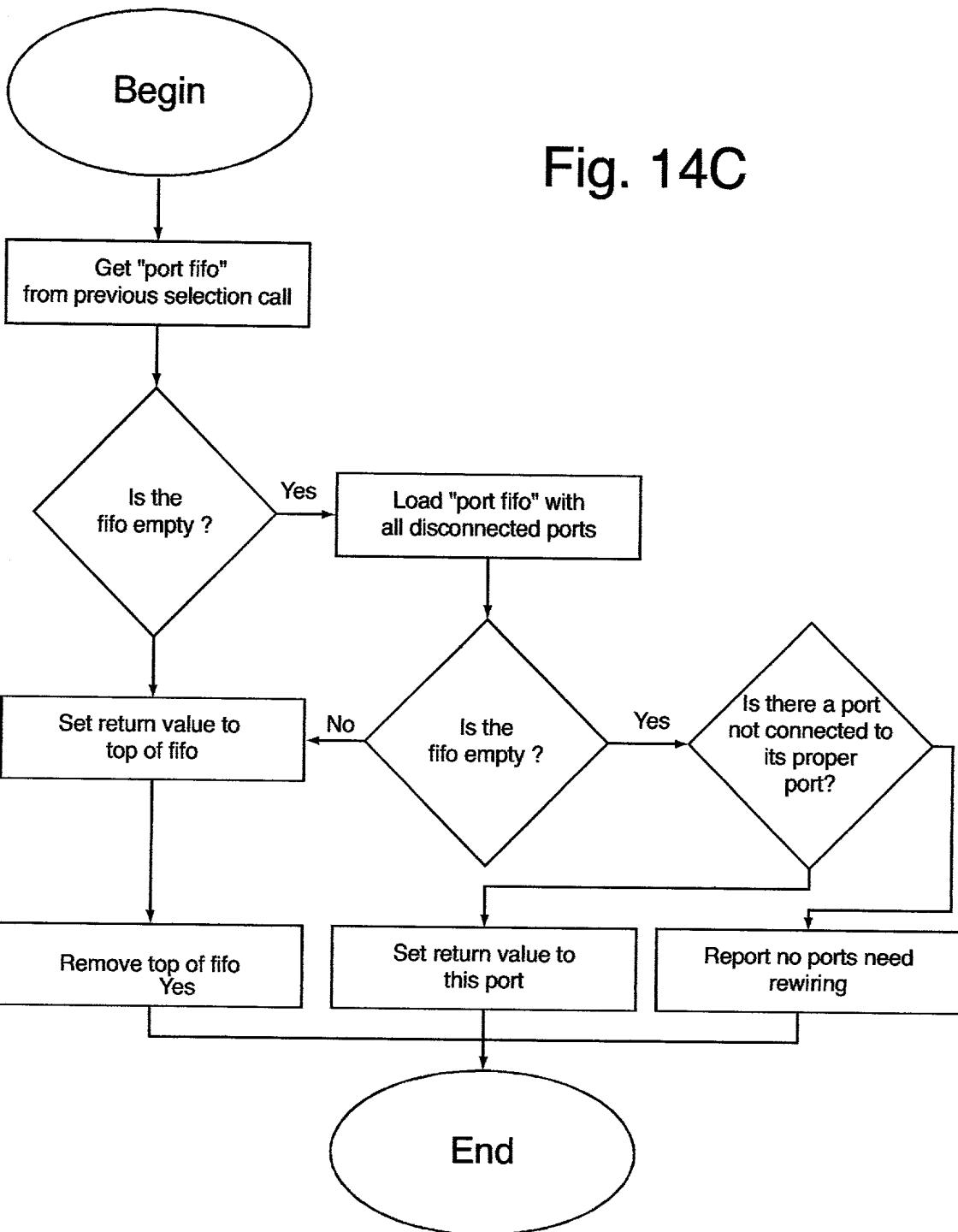


Fig. 14C

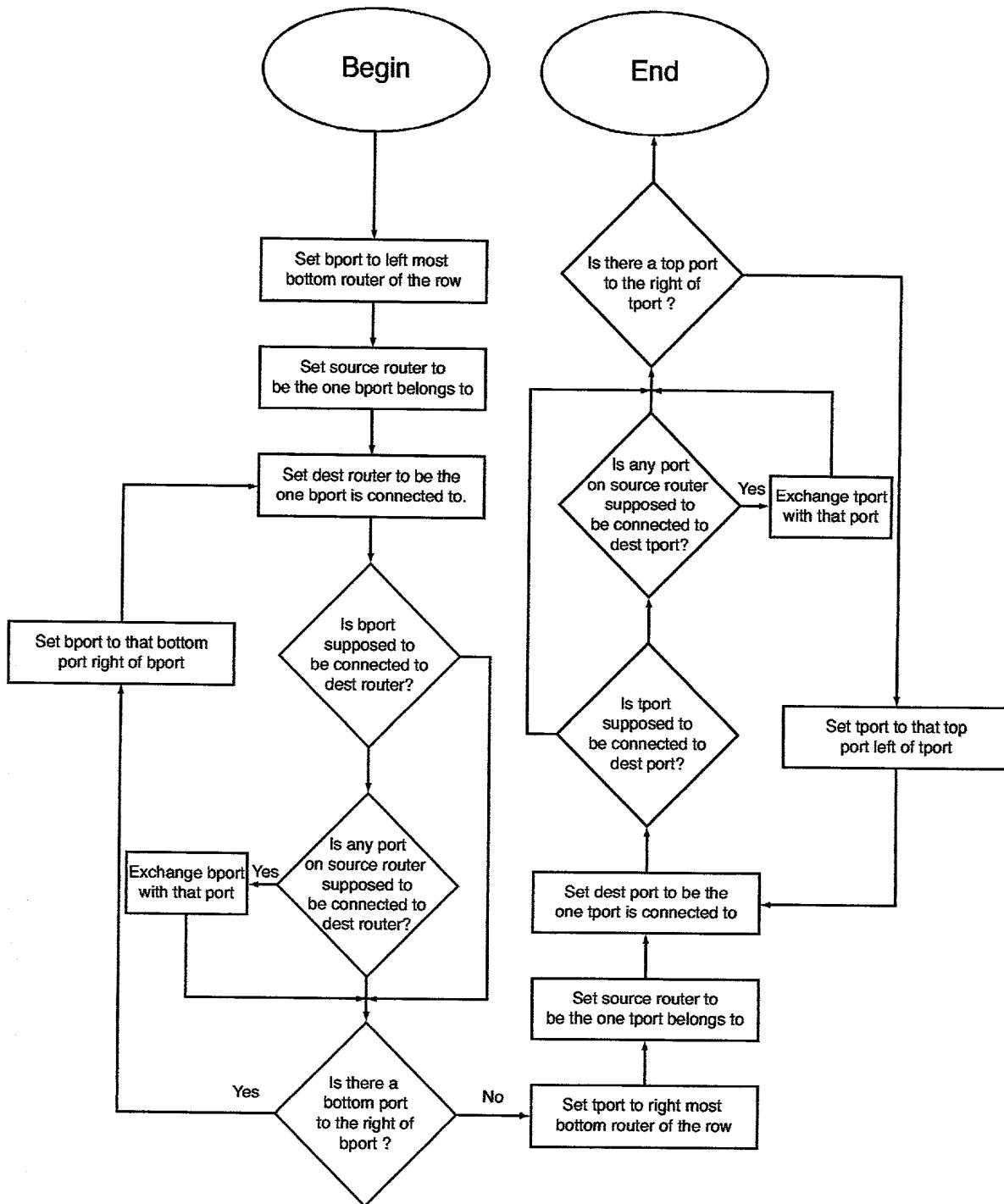


Fig. 15